CE-441- ENVIRONMENTAL ENGINEERING II

Lecture 1- Introduction to Wastewater Collection System

Engr. Abdul Mannan Zafar

Lecturer,
Institute of Environmental Engineering & Research (IEER)
University of Engineering and Technology, Lahore

amzafar@uet.edu.pk

Improper Sanitation

Objectives

1. Learn Basic Concepts of Wastewater Engineering
2. Design Wastewater Collection System
3. Learn Basic concepts& design of Wastewater treatment processes

COURSE OUTLINE

1. Sources of wastewater: Municipal and industrial.
2. Estimation of sanitary sewage and storm water quantities.
3. Hydraulics of sewers and design of sewerage systems. Sewage pumping.
4. Characteristics of municipal and industrial wastewaters.
5. Wastewater Treatment: Purpose, principle and design of various waste treatment processes including screening, grit chambers, sedimentation tanks, activated sludge process, trickling filters, wastewater stabilization ponds and aerated lagoons. Sludge digestion and disposal. Solid mass balance.
6. Low cost sanitation options for rural areas and small communities. Disposal of wastewater on land and into water bodies. Waste assimilation capacity of streams. Use of treated effluents for irrigation.
7. National Environmental Quality Standards.
8. Introduction to environmental impact assessment. Evaluation of environmental impacts.

Basic Terms

- Sewage: It is the Liquid Waste or Wastewater produced as a result of water use.
- Sewer: It is a pipe or conduit for carrying sewage. It is generally closed and flow takes place under gravity

.

Sewer

Sewage

Basic Terms

- **Sewerage:** Sewerage is the system of collection of wastewater and conveying it to the point of disposal with or without treatment

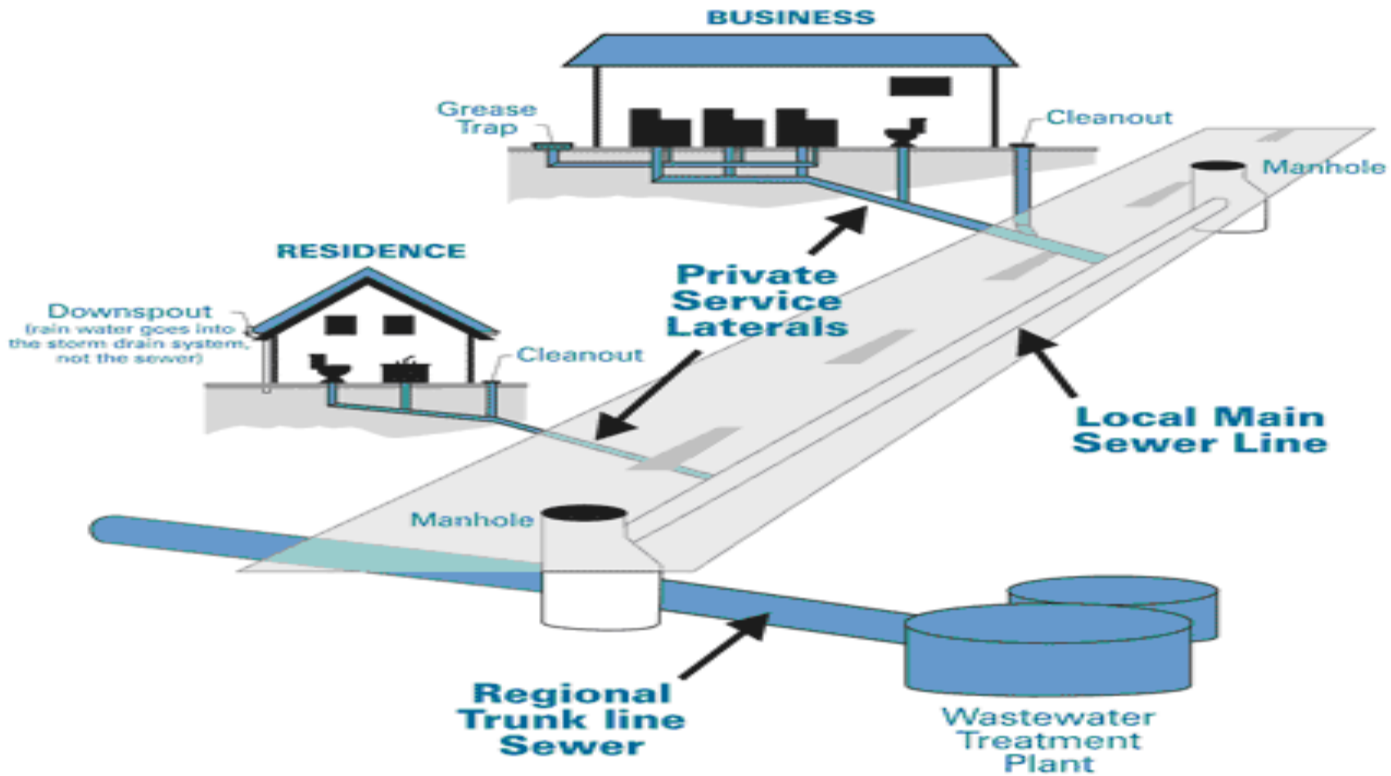
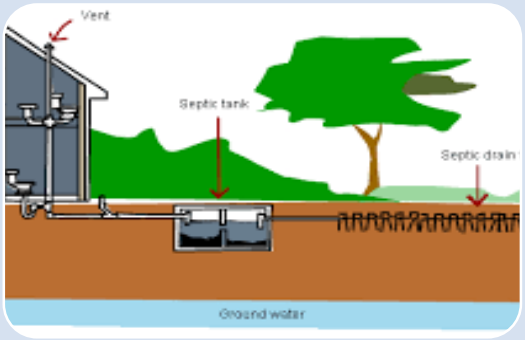


Diagram of a sanitary sewer system

Sources of Wastewater



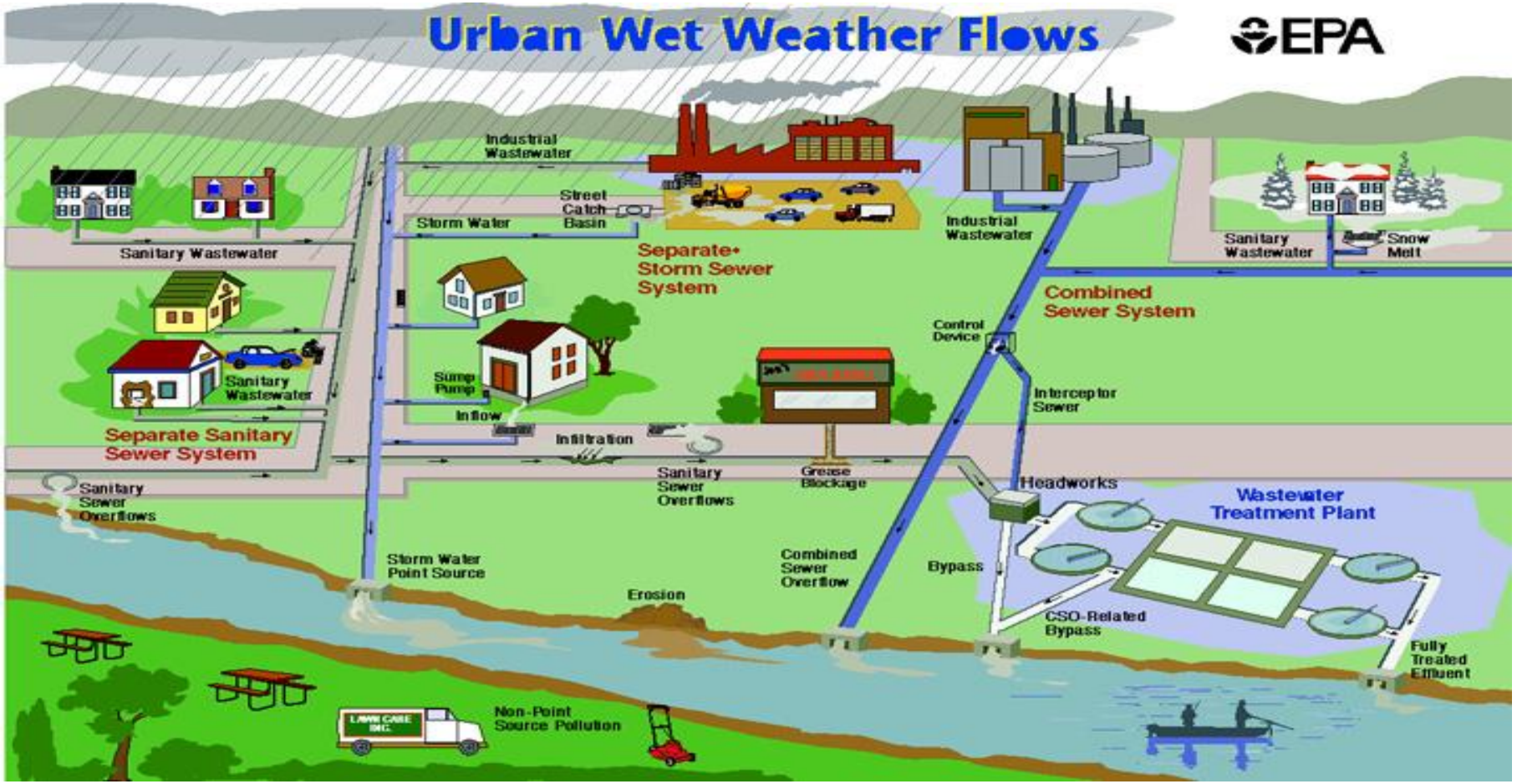
Domestic

Industrial

Storm water

Components of Wastewater Engineering

1. Collection System → Network of Sewer pipes
2. Disposal → Sewage Pumping Stations and Outfalls
3. Treatment Works → Wastewater treatment Plants



Types of Sewers

1. Sanitary Sewer- It carries sanitary sewage like waste from municipalities including domestic and industrial waste-water
2. Storm Sewer-It carries storm sewage including surface run-off and street wash
3. Combined Sewer- It carries domestic, industrial and storm Sewage
4. House Sewer-It is the sewer conveying sewage from plumbing system of a building to common municipal system
5. Lateral Sewer- This sewer carries discharge from houses sewer

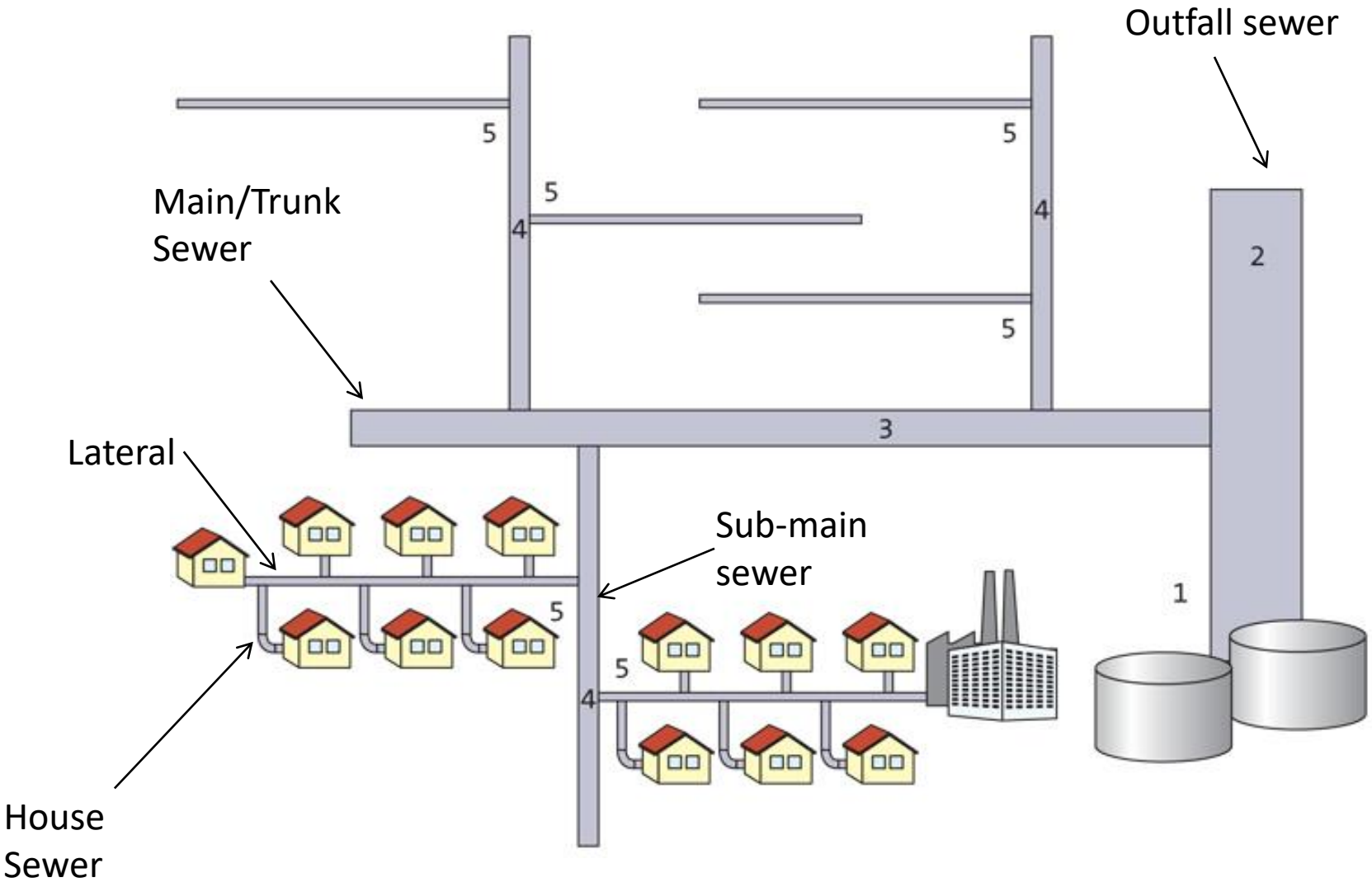
Types of Sewers

6.Sub-main-This sewer receives discharge from two or more laterals

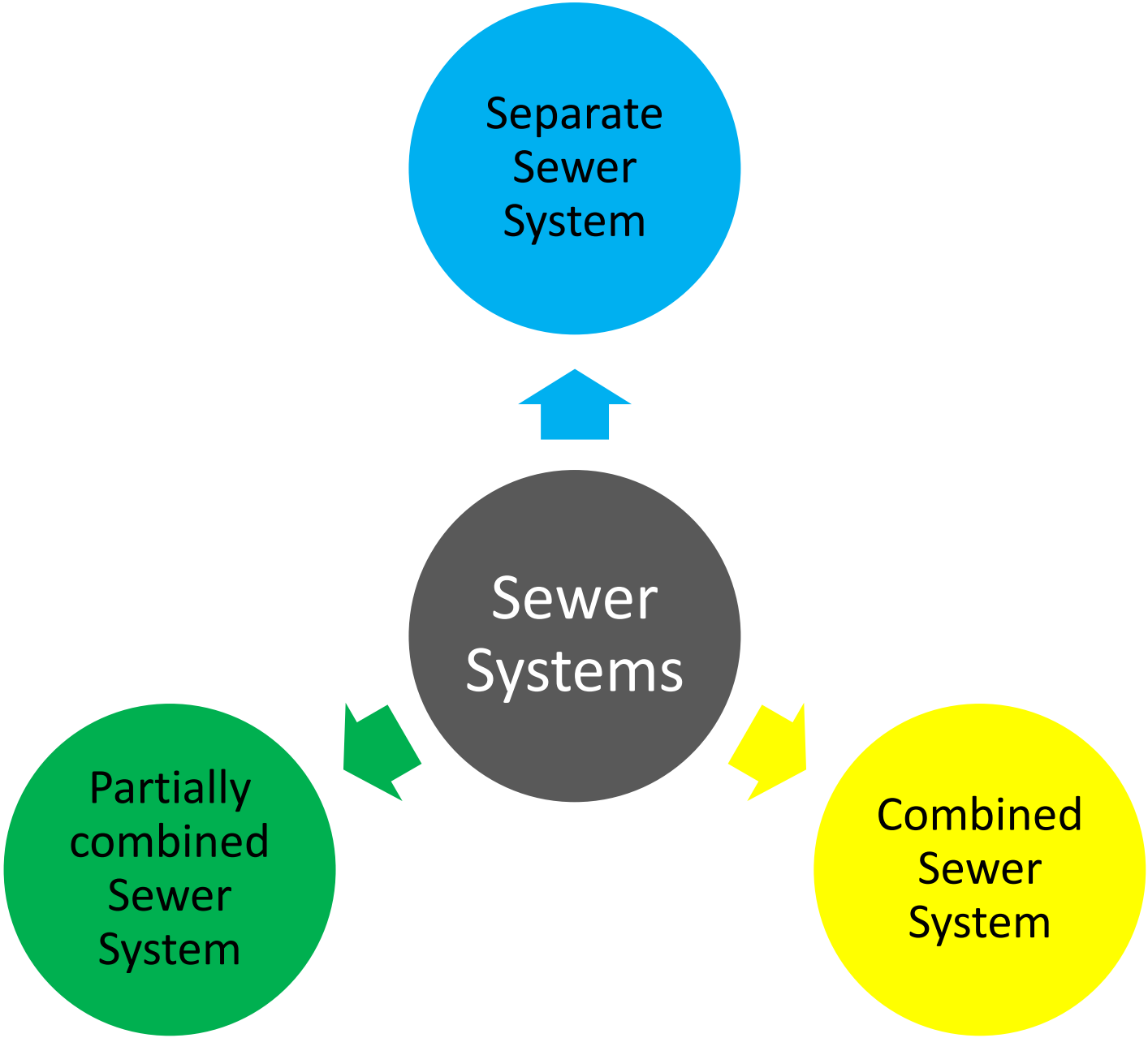
7.Main/Trunk Sewer- Receives discharge from two or more sub-mains

8. Outfall Sewer- It receives discharge from all collecting system and conveys it to the point of final disposal

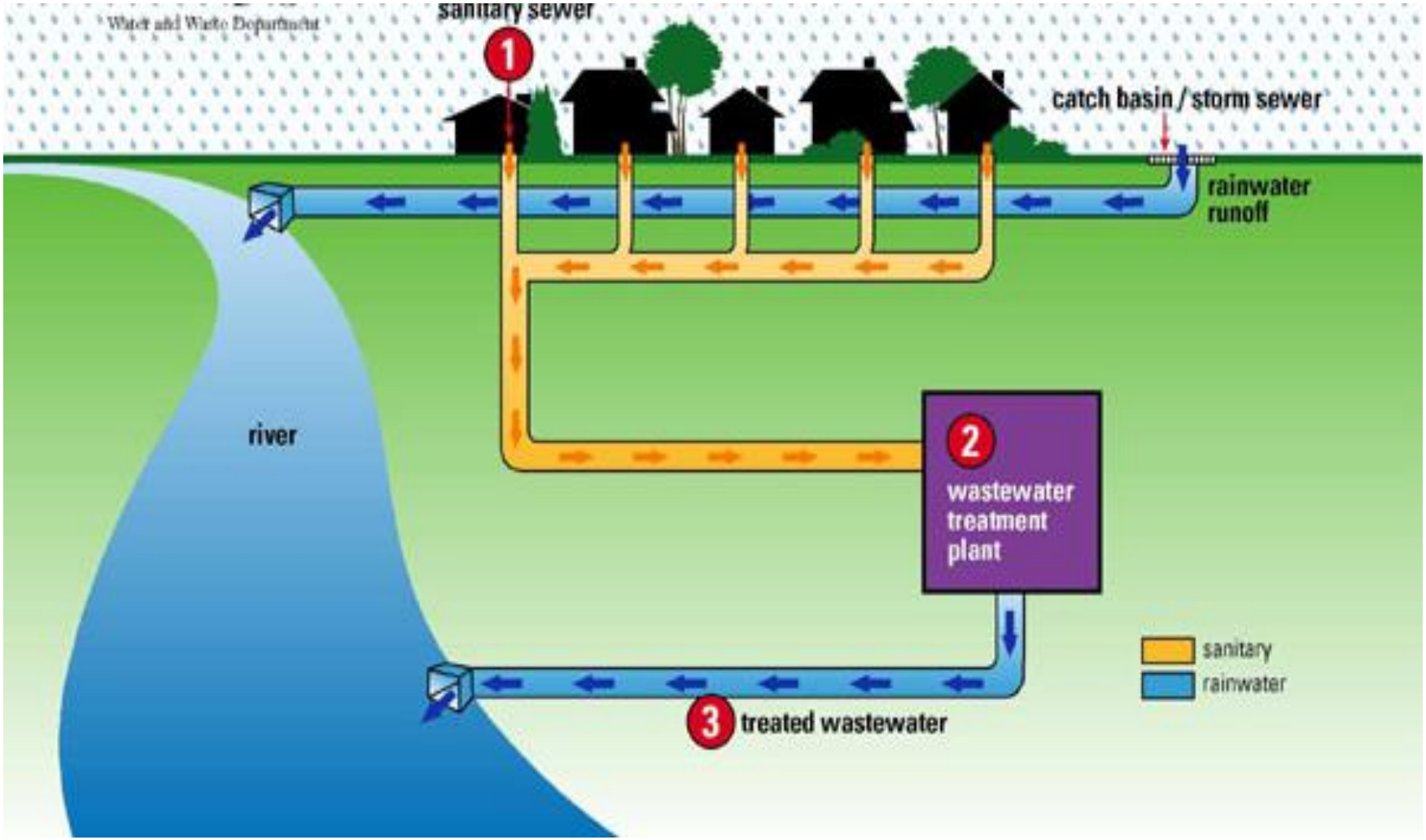
Types of Sewers



Types of Sewer System



1. SEPARATE SYSTEM



1. SEPARATE SYSTEM

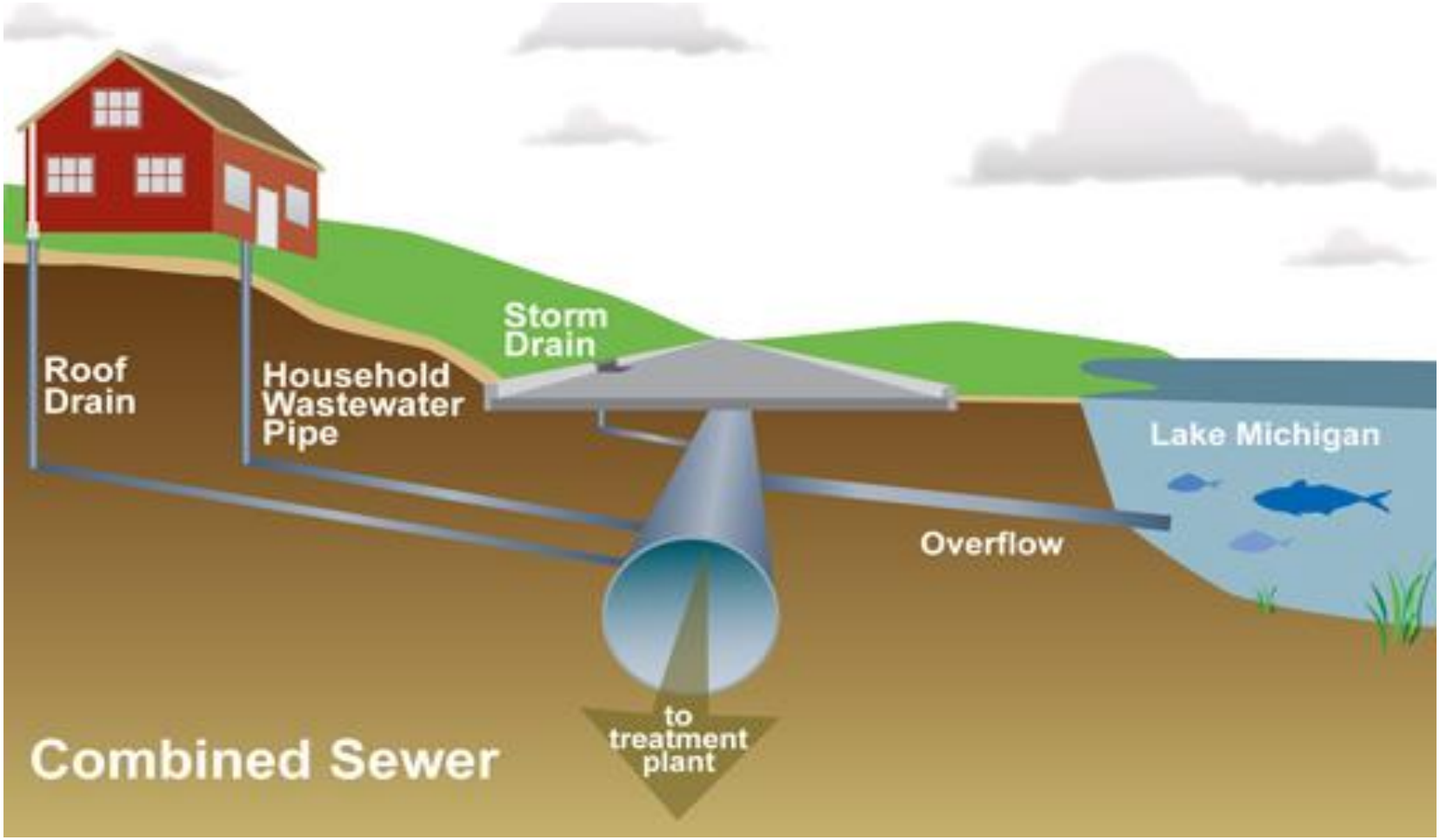
If storm water is carried separately from domestic and industrial wastewater the system is called as separate system.

Separate systems are favored when

(i) There is an immediate need for collection of the sanitary sewage but not for storm water.

(ii) When sanitary sewage needs treatment but the storm water does not.

2. COMBINED SYSTEM



2. COMBINED SYSTEM

It is the system in which the sewers carry both sanitary and storm water, combined system is favored when;

(i) Combined sewage can be disposed off without treatment

(ii) Both sanitary and storm water need treatment

(iii) Streets are narrow and two separate sewer cannot be laid

3. PARTIALLY COMBINED SYSTEM

If some portion of storm or surface run-off is allowed to be carried along with sanitary sewage the system is known as partially combined system.

(In Urban area of developing countries, mostly partially combined system is employed as it is economical)

In Pakistan we use this system

Note

- Sanitary wastewater is not allowed to discharge in any stream without treatment.

- When there is storm water inside the sewer, some portion of sanitary sewer might go as its effects would be less since due to dilution .

- Sanitary wastewater remains at the bottom usually because of high density than storm water.

Infiltration

"It is the wastewater that enters sewers through poor joints, cracked pipes, and the walls of manholes."

- Infiltration is almost non-existent in dry weather but increases during rainy season
- Water and Sanitation Agency (WASA) Lahore uses the following infiltration rates for the design of sewer system.

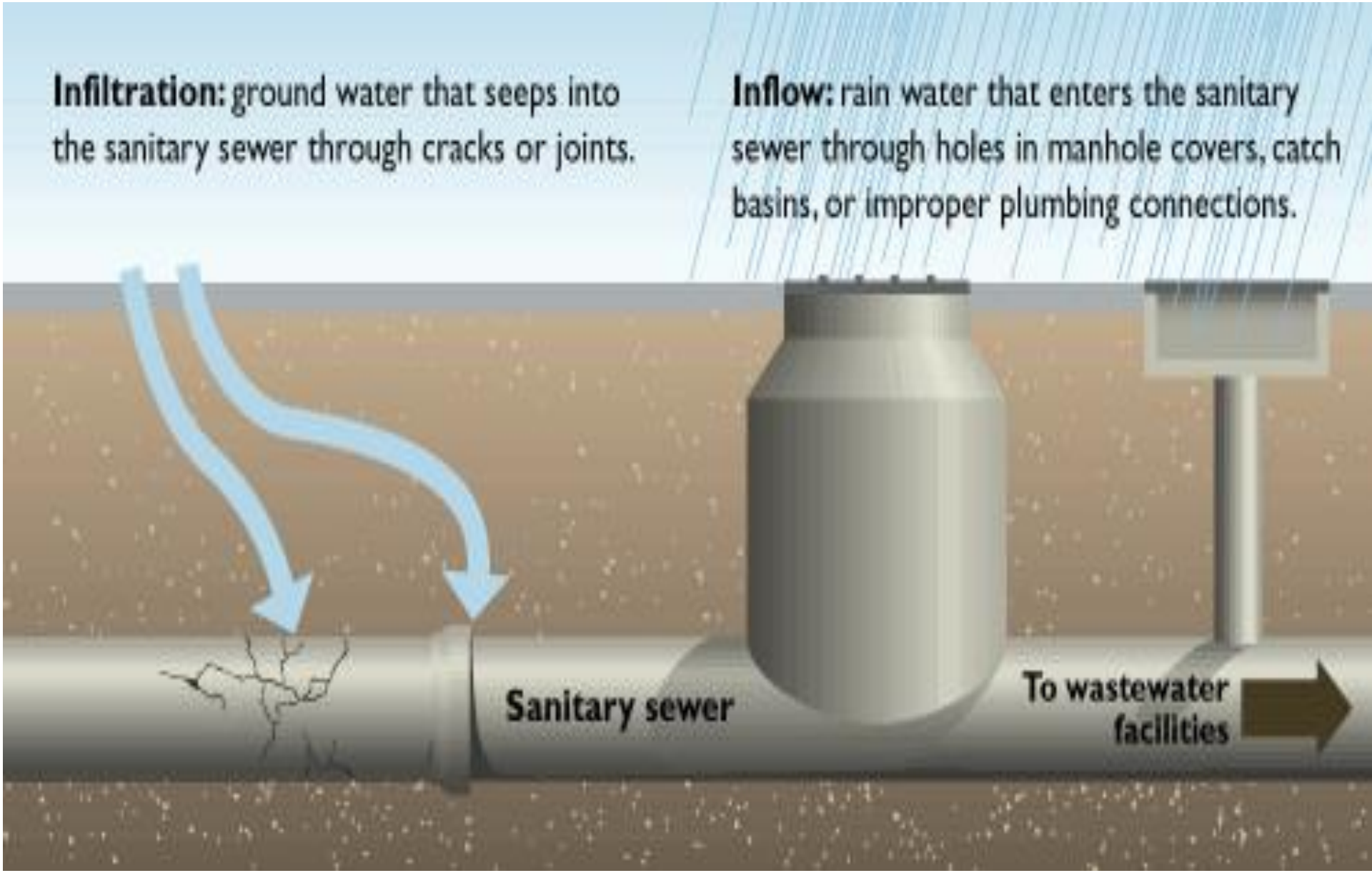
Pipe dia. Up to 600mm → 5% avg. Sewage flow

For greater than 600mm→ 10% avg. Sewage flow

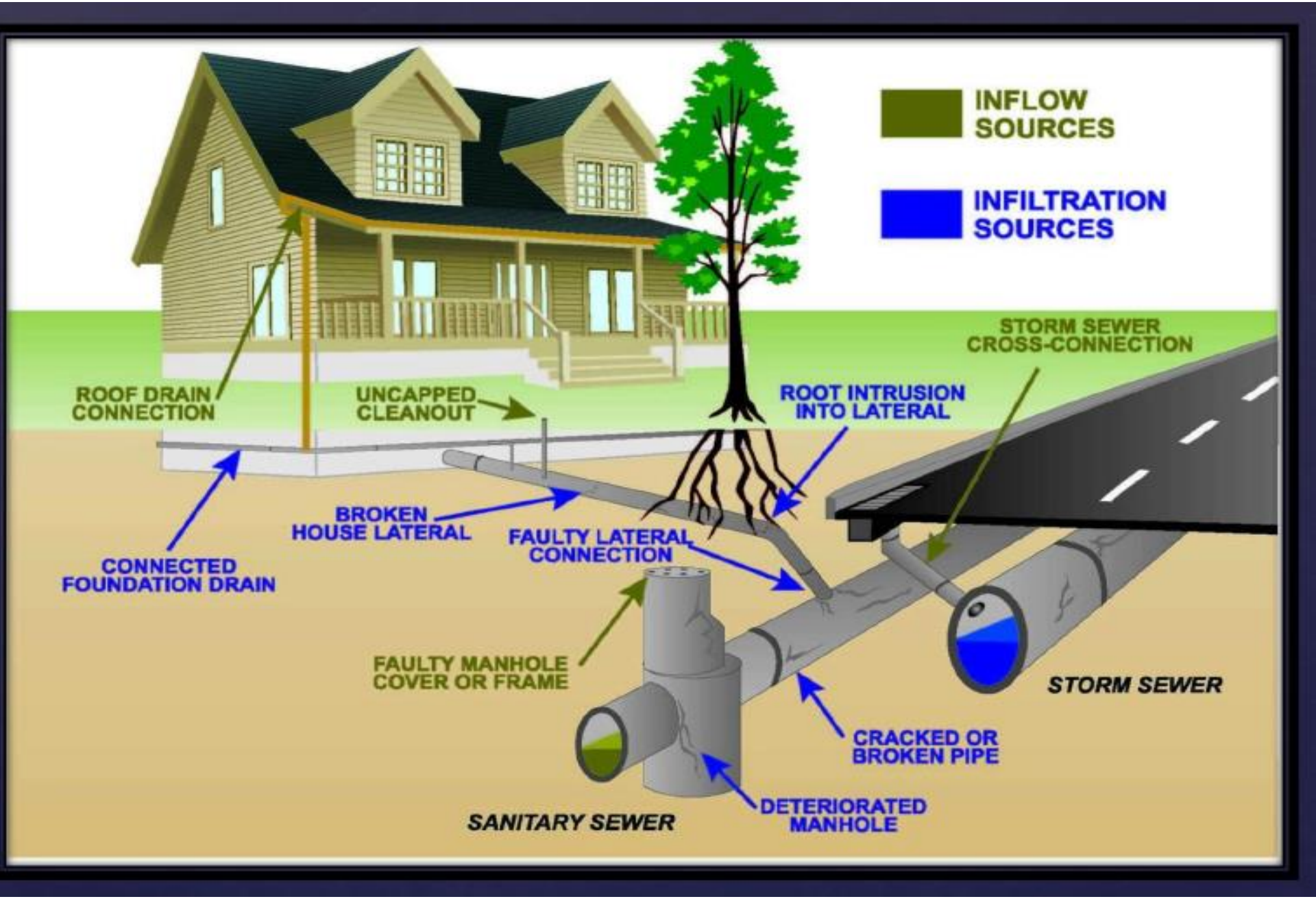
Inflow

"It is the water that enters to the sewer through perforated manhole covers, roof drains, and drain from cellars during runoff events."

Infiltration & Inflow



Infiltration & Inflow- Sources



Sewage Generation & Water Consumption

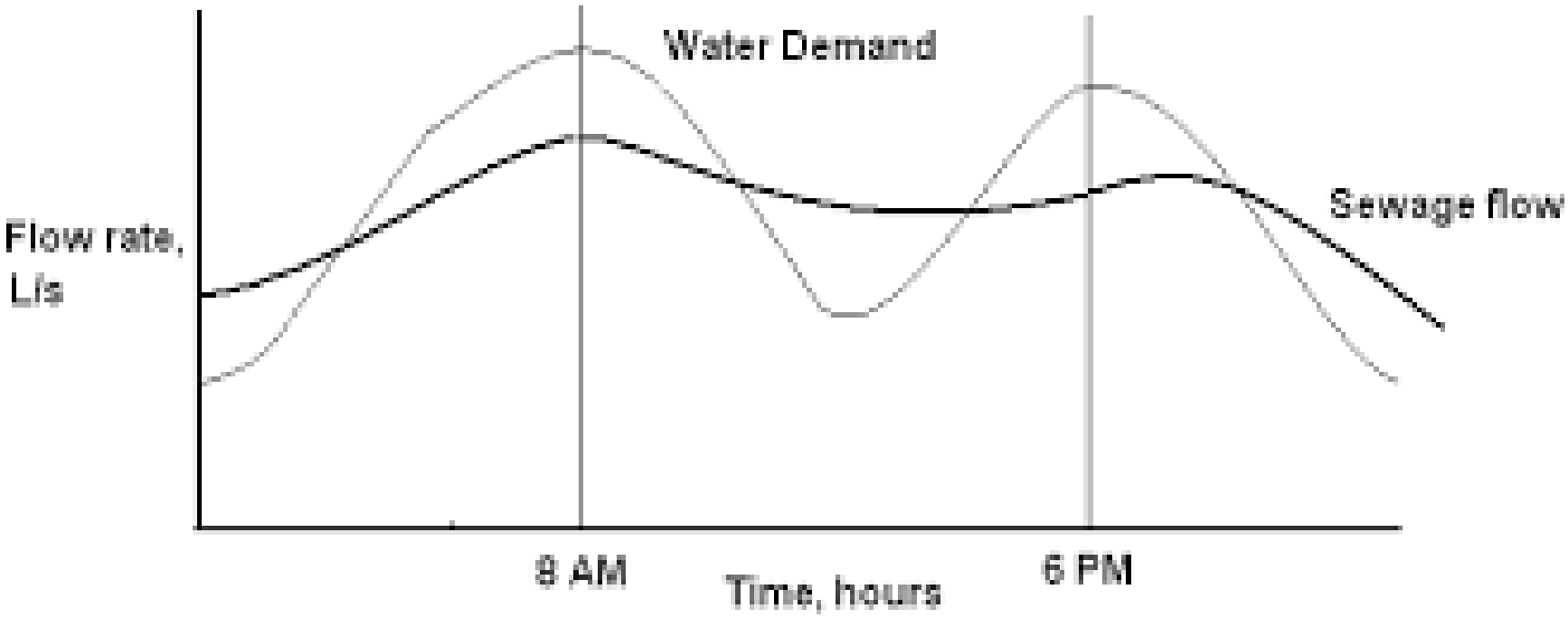
- Around 70-130% of water consumed gets into sewers

1. Industries with private point of discharge
2. Poor Sewer joints

→General Range 70-90% of water consumption when infiltration is taken into consideration then **Avg. sewage flow equals the avg. rate of water consumption**

Variation in Sewage Flow

- Like Water Supply the sewage flow varies from time to time since the sewers must be able to accommodate the max. rate of flow the variation in sewage flow need to studied



Typical hourly distribution of sewage flow

Variation in Sewage Flow-Peaking Factor

HERMAN FORMULA: is used to estimate the ratio of max. to avg. flow

$$M = \frac{Qmax.}{Qavg.} = 1 + \frac{14}{4 + \sqrt{P}}$$

Where,

P = Pop. In 1000

M = Peak Factor

Water Supply & Sanitation Agency(WASA), Lahore consider the following relationship for sewer design

Average Flow (m3/day)	Peak Factor
< 2500	4
2500-5000	3.4
5000-10000	3.1
10000-25000	2.7
25000-50000	2.5
50000-100000	2.3
100000-250000	2.15
>500000	2

Variation in Sewage Flow

- Minimum rate of Sewage Flow

  Generally taken as 50% of avg. sewage

- It is used in the design of sewage pumping station

- To investigate the velocities in sewer during Low Flow periods

Peak factor-Numerical

- If a sewage flow monitored from a subdivision was measured at 8,640,000 L for a 24 hours period and the measured flow rate at the time of peak usage was 0.22m3/s. Calculate the peaking factor for above mentioned subdivison.

Numerical

- The residential area of a city has a population density of 15000 persons/ Km^2 and an area of 120,000 m^2. If the average water consumption in 400 lpcd. Find the average sewage flow and the maximum sewage flow that can be excepted in m^3/day.

Design Period

"The future period for which the provision is made in designing the capacities of the various components of sewage scheme is known as Design period".

The design period depends upon the following:

1. Ease and difficulty in expansion,
2. Amount and availability of investments,
3. Anticipated rate of growth of population, including shifts in communities, industries, and commercial investments,
4. Hydraulic constraints of the system designed, and
5. Life of material and equipment

1. Design of Sewer System

Period of design is indefinite as the system is designed to care for the maximum development of area which it serves.

-Use of Qmax (maximum flow) for sewer design

-Use of Qmin (minimum flow) to check velocities during low flow

Design Period and Use of Sewage Flow Data

2. Design of sewage pumping station

-Design period is usually 10 years

-We consider average daily flow , peak and minimum flow including infiltration

3. Design of sewage treatment Plants

-Design period is usually 15-20years,

-Require data of average flow , infiltration , peak flow